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Published in:
Journal of Trauma

Publication date:
1998

Document version
Accepted author manuscript

Document license
Unspecified

Citation for pulished version (APA):
Faergemann, C., Frandsen, P. A., & Röck, N. D. (1998). Residual impairment after lower extremity fracture. Journal of Trauma, 45(1), 123-6.

Residual Impairment after Lower Extremity Fracture

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In a prospective follow-up study of 158 consecutive patients 18 to 64 years old with unilateral lower extremity fracture, our aim was to disclose the impairment and disability 6 months after the injury. The patients were interviewed within 1 week after the trauma, and all patients returned to the hospital for an interview and a clinical assessment 6 months later. The disability was measured by administering the Sickness Impact Profile (SIP) to all patients by an interview process. SIP scores were calculated for pretraumatic and posttraumatic states. The pretraumatic SIP scores described the functional status before the injury. Additionally, three major aspects of impairments were measured 6 months after the fractures: range of motion, muscle strength, and pain. Most patients had a significantly higher SIP score 6 months after the fracture(s) than pretraumatically. The mean overall SIP score was 2.7 pretraumatically and 8.7 6 months posttraumatically. Major deficits in range of motion was observed, especially in the ankle joint. Additionally, loss of muscle strength was observed in the thigh and calf muscles in one fourth of the patients. Only low levels of residual pain were reported after 6 months.

Lower extremity fracture is one of the leading causes of all trauma treatment and hospitalization among adults below the age of 65.[1] The trauma section at the Odense University Hospital receives more than 900 patients annually with a fracture of a lower extremity in this age group.

Despite the high incidence, little is known about the long-term consequences after these fractures in this age group. Most papers describe the dynamics of the trauma, the epidemiology, and the surgical treatment. The overall goal of orthopedic care after trauma should be the restoration of function, allowing the patients to return to normal everyday activities. Within the past 10 years, social rehabilitation after fractures has become a major topic of interest in medical science. Most of these reports, however, have dealt with the short-term results, the outcome after hip fractures among the elderly, or the outcome after more complex fractures. An increased knowledge about the outcome after these injuries may be a very helpful and a relevant instrument for the clinicians daily work with the patients. A major study has demonstrated a moderate level of impairment and disability after severe lower extremity fracture treated in a Level I trauma center.[2,3] The aim of our study is to elucidate the moderate long-standing impairment and disability after unilateral lower extremity fracture.

PATIENTS AND METHODS

A prospective follow-up study of 158 consecutive patients 18 to 64 years old admitted to the Department of Orthopedics, Odense University Hospital, Denmark, with unilateral lower extremity fracture between September 1, 1994, and January 31, 1995 was conducted. Included were all patients with fractures of the femur and distally, excluding isolated phalangeal fractures, which generally result in little impairment unless accompanied by another injury. Also excluded from the study were (1) patients with associated fractures of the upper extremity or the spine, (2) patients with bilateral lower extremity fractures, (3) patients with pathologic fractures, and (4) patients with a major psychiatric illness. Patients were also excluded if they did not speak Danish.

The study was approved by the Committee of Ethics, County of Funen, and informed consent was obtained from all patients participating in the study.

All patients included in the study were interviewed before discharge from the hospital, or in the outpatient department the following week, or by telephone within a few days if they received ambulatory treatment. The purpose of the interview was to characterize the patient's functional status before the injury. For all patients, the following information was obtained from the medical record: age, gender, cause of the injury, employment status, and diagnosis.

A total of 251 patients were asked to participate in the study, and informed consent was obtained from 205 (82%) who went through the first interview. Thirty-five percent of the patients were interviewed before discharge, 30% were interviewed in the outpatient department, and 35% were interviewed by telephone.

At 6 months, 158 (77%) patients with 166 fractures returned to the hospital for the second interview, and a supplementary physical examination describing the residual impairment and disability by measuring range of motion (ROM), muscle strength, and pain.

ROM was measured in each joint of both lower extremities by standard goniometric techniques recommended by the American Academy of Orthopedic Surgeons.[4] The goniometer was a full-circle manual goniometer, Zimmer, Ltd., Bridgend, Glamorganshire, UK. A ratio (ROM-ratio) was calculated between the ROM in the two extremities in all patients. A ROM-ratio < 0.9 indicates loss of ROM in the injured extremity.[5]

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This study was supported by Sahva Orthopedics, the University of Odense, and the Fehr Foundation.

Presented at the 3rd International Conference on Injury Prevention and Control, February 1996, Melbourne, Australia.

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Using a reliable and valid isometric stationary dynamometer, muscle strength was measured in both extremities in all patients. A ratio was calculated between measured muscle strength in the two extremities. A muscle strength ratio < 0.75 indicates loss of muscle strength in the injured extremity.

Pain was subjectively measured using the Visual Analogue Scale of Pain (VASPain), a reliable and valid measure for estimating the intensity of pain.[6–10]

The disability was measured by administering the Sickness Impact Profile (SIP) in all patients at the two interviews. SIP scores were calculated for pretraumatic and posttraumatic states. The pretraumatic SIP score indicated the patients functional status pretraumatically. SIP is a standardized instrument that consists of 136 statements describing health-related dysfunctional behaviors.[11–14] The statements are grouped into 12 categories of dysfunction: body care and movement, mobility, ambulation, emotional behavior, social interaction, alertness behavior, communication, sleep and rest, home management, work, recreation and pastimes, and eating. SIP scores are calculated using weights that reflect the relative severity of each dysfunction. Scores can be computed for each of the 12 categories and for the overall SIP catalogue. Additionally, three subscores that describe a physical, a psychosocial, and an independent dimension can be calculated. The SIP scores each range from 0 to 100, the higher the score, the higher the level of disability. The pretraumatic and posttramatic SIP scores were compared using nonparametric Wilcoxon paired statistics. The probability level of $p < 0.05$ was considered significant. Additionally, the number of days off work for each patient were evaluated 6 months posttraumatically.

RESULTS

The characteristics of the patients are summarized in Tables 1–3. The mean age of the study population was 44 years (range, 18–64 years). Mean age of the male population was 41 years (range, 18–64 years), and mean age of the female population was 47 years (range, 18–64 years). Most of the fractures were caused by a low energy trauma. Six patients had two fractures, and one patient had three fractures of a lower extremity.

The residual impairment 6 months posttraumatically is summarized in Tables 4 and 5 and Figure 1. For all motions, the mean observed ROM was significantly less in the injured extremity than in the uninjured extremity, except for extension of the knee joint. The largest deficits were observed for the ankle joint, because about half of the patients had abnormal dorsi/plantar flexion in the ankle joint (Table 4).

The decrease in muscle strength of the injured extremity relative to the uninjured extremity was most pronounced in

TABLE 1. Demographic characterization of the study population

Characteristic	Number (%)
Gender	
Male	87 (55)
Female	71 (45)
Age (years)	
18–29	37 (23)
30–49	61 (39)
50–64	60 (38)
Preinjury activity	
Working	93 (59)
Unemployed	17 (11)
School	15 (9)
Retired	33 (21)

TABLE 2. Characteristics of trauma

Cause of Injury	Number (%)
Motor vehicle	6 (4)
Motorcycle	10 (6)
Sport	44 (28)
Fall	70 (44)
Work	27 (17)
Violence	1 (1)

TABLE 3. Location of fracture

Location	Number (%)
Proximal femur	11 (6)
Shaft of femur	3 (2)
Distal femur (including periarticular)	1 (1)
Patella	8 (5)
Proximal tibia (including periarticular)	9 (5)
Shaft of tibia	1 (1)
Distal tibia (including pilon)	5 (3)
Ankle	68 (41)
Fibula	4 (2)
Calcaneus	6 (4)
Talus	8 (5)
Tarsus/metatarsus/phalanx	42 (25)
Total	166 (100%)

TABLE 4. Percentage of patients with abnormal ROM ratio (<0.90)

Motion	Percentage Abnormal
Hip joint	
Flexion	10
Extension	10
Knee joint	
Flexion	11
Extension	2
Ankle joint	
Dorsiflexion	54
Plantarflexion	56

TABLE 5. Percentage of patients with abnormal muscle strength ratio (<0.75)

Muscle Group	Percentage Abnormal
Hip	
Flexors	13
Extensors	12
Knee	
Flexors	15
Extensors	17
Ankle	
Dorsiflexors	18
Plantar flexors	25

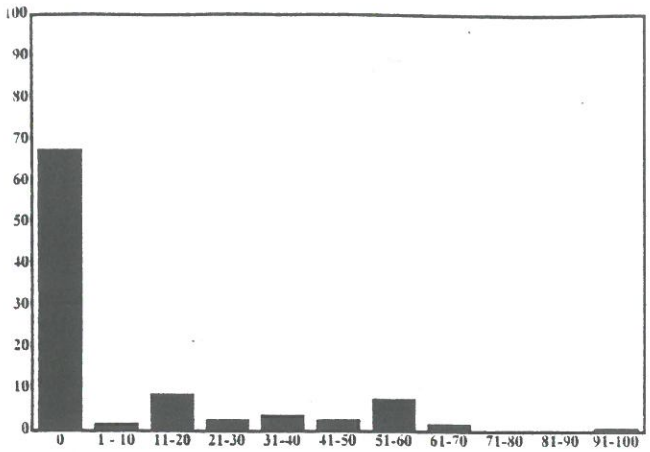

FIG 1. **VASPain scores in patients as percentage of all patients.**

he ankle plantar flexors, ankle dorsiflexors, and knee extensors. For each of these groups of muscles, the relative strength was less than 0.75 for between 17 and 25% (Table 5).

The distribution of VASPain scores are shown in Figure 1. Only low levels of pain were reported. The mean VASPain score was 11 (range, 0–96). A total of 108 patients (69%) reported no pain at all, and only nine patients (6%) had pain at levels thought of as substantial (>50 mm on a 100-mm line).

Table 6 presents the pretraumatic and the 6 months posttraumatic SIP scores for all patients in the study population. The overall SIP score averaged 8.7 posttraumatically and 2.7 pretraumatically, indicating a moderate rise in level of disability after 6 months. The 6 months mean scores were significantly higher than the pretraumatic scores for all categories except communication and eating. The highest scores were related to emotional behavior, ambulation, and recreation and pastimes.

TABLE 6. **Mean SIP scores pretraumatically and 6 months posttraumatically in 158 patients with unilateral lower extremity fracture**

SIP	Pretraumatic	Posttraumatic	*p* Value[a]
Physical dimension	2.6	10.7	<0.001
Body care and movement	2.1	9.3	<0.001
Mobility	2.3	6.6	<0.001
Ambulation	4.1	15.4	<0.001
Psychosocial dimension	1.3	6.7	<0.001
Emotional behavior	2.1	14.4	<0.001
Alertness behavior	1.1	5.2	<0.001
Social interaction	1.5	6.5	<0.001
Communication	0.5	0.6	NS[b]
Independent dimension	4.5	9.4	<0.001
Sleep and rest	3.1	8.0	<0.001
Home management	5.3	12.0	<0.001
Work	11.7	16.3	<0.001
Recreation and pastimes	4.6	13.2	<0.001
Eating	0.1	0.5	NS[b]
Overall SIP score	2.7	8.7	<0.001

[a] Nonparametric statistics.
[b] Nonsignificant.

Analysis of the subgroup of those patients who were working at the time of the injury showed that 96% had returned to work after 6 months. The average number of days off work was 45 days (range, 0–180 days). Twenty-seven percent of the patients were able to work full-time without any sick-leave.

DISCUSSION

The distribution of the fractures in our study seems to be a little different from the distribution of lower extremity fractures in some other Western countries, because we have more foot and ankle fractures and fewer femoral and tibial shaft fractures than, e.g., a typical Level I trauma center in the United States. There might be several explanations for that finding. First, we have fewer high energy injuries in Denmark compared with many other Western countries, just as we have fewer traffic accidents and injuries caused by violence. Second, there are differences between a Level 1 trauma center and the trauma section at a Danish University Hospital, because we are treating all trauma patients (mild to severe) in a well-defined geographical area. The distribution of fractures in our study reflects the distribution of isolated lower extremity fractures treated at Odense University Hospital and in Denmark.

This explanation is supported by the trauma characteristics in our study, because traffic accidents and violence were responsible for only 11% of the injuries. It may also explain the distribution of age in our study, with more than three fourths of the patients older than 30 years of age.

Impairment of the lower extremity was assessed in this study by measuring limitation in ROM, limitation in muscle strength, and pain. The overall results of the study indicate that two of three of the patients admitted to the hospital for a lower extremity fracture remain physically impaired 6 months after the trauma.

More than half of the patients had lost ROM in at least one joint in the injured extremity 6 months posttraumatically. Most frequently affected was the ankle joint, which was related to the large number of fractures anatomically associated with the ankle or the lower leg. In another study of residual impairment 6 months after unilateral fracture of the lower extremity, the loss of ROM was twice as high as in our study.[2] However, their study was carried out in a Level I trauma center with more patients with severe injuries, i.e., half of the fractures were caused by a high-energy trauma. Tropp and Norlin[15] examined the outcome of unilateral ankle fractures and found restricted ROM in all patients on the affected ankle joint after 10 weeks but fully restored ROM after 1 year, suggesting that a longer follow-up of our patients may result in a further improvement in ROM. Also, the choice of treatment seems to effect joint mobility. No reduction in ROM was seen in the knee, ankle, and subtalar joints 6 months after an unstable tibial shaft fracture treated with unreamed interlocking nails.[16] In our study, a large group of these patients were treated conservatively, which may explain the large number of patients with loss of ROM.

Muscle strength was also reduced in our study, as 12 to

25% had loss of muscle strength in at least one muscle group in the injured extremity 6 months posttraumatically. Most affected were the dorsiflexors and plantar flexors of the ankle joint, which is in accordance with MacKenzie et al.[2] The dynamometer used in our study has been subject to testing of the reliability and validity, which were both found high.

In our study, pain was only a major problem in 6% of the patients and more than two of three patients reported no pain at all. In the study by MacKenzie et al.[2] from a Level I trauma center of the long-term outcome after unilateral lower extremity fracture, a significant higher mean VASPain score was found after 6 months just as three of four of the patients reported pain 6 months posttraumatically.

We measured disability by using SIP and counting the number of days off work. The mean overall SIP score indicated a moderate rise in level of disability 6 months after the injury, because the SIP score increased from 2.7 pretraumatically to 8.7 posttraumatically. The increase in SIP scores represent dysfunction across several domains of everyday living. Not only do patients continue to have difficulties ambulating at 6 months, but they also report changes in their emotional behavior and difficulties in resuming their previous recreational activities. A single study has demonstrated higher SIP scores and a higher degree of disability 6 months after lower extremity fracture.[2] Also found here, disability was widely distributed across the spectrum of activities of daily living.[2,3] These studies were carried out in a Level I trauma center at which more severe injuries are treated. In our study patients were recruited from Odense University Hospital, which treats all injuries in the community. The SIP questionnaire has several strengths as a health status measure. First, it is a multidimensional measure. In addition to an overall SIP score, the SIP provides subscores for 12 different areas of dysfunction. These subscores can be used to develop a profile of health status. Second, SIP has been subject to extensive testing for test-retest reliability and validity.[13,14]

The number of days off work varied considerably. More than 25% of the patients were able to work the day after the injury, whereas only 4% were still on the sick list 6 months after the injury. The number of days off work seems to be determined by the location of the fracture. The mean number of days off work was 59 days among patients with fractures of the femur; 56 days for patients with fractures of the patella, tibia, or fibula; and 31 days for patients with fractures of the foot. Similar results have been achieved in other studies of patients with fractures or dislocations of the extremities.[17,18]

A relatively large number of our cases were on-the-job injuries. Some subjects may play down preinjury problems and play them up after the injury to achieve a slower return to work and an increased economic compensation. However, such tendencies have so far not been demonstrated in Denmark.

Acknowledgment

The authors would like to thank Dr. Anders Bonde Jensen for valuable discussions.

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